Opbygning af en fleksibel CAD mode for CFD beregninger på DTU's Økobil

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Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Opbygning af en fleksibel CAD model for CFD-beregninger på DTU's Økobil

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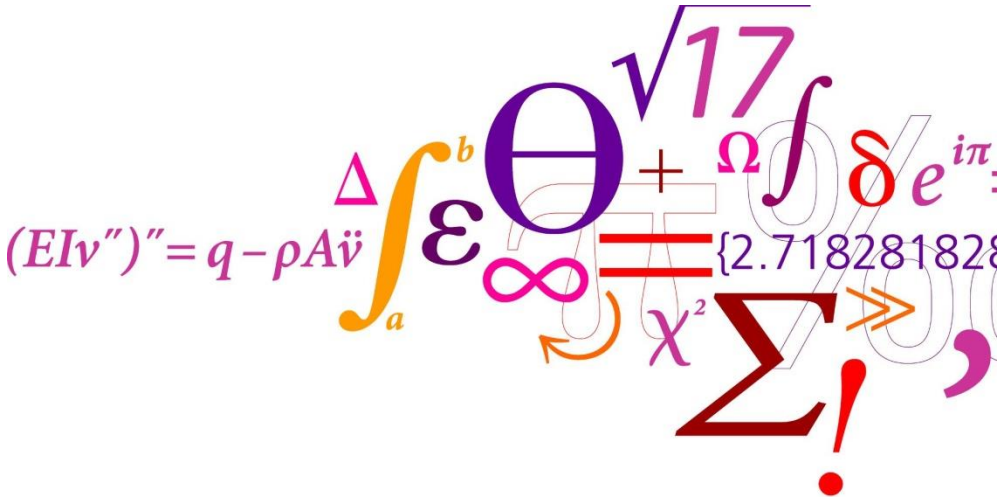
Bygning 426 B



DTU Mekanik
Institut for Mekanisk Teknologi

Disposition

1) Baggrund for arbejdet
2) Indledende modeller og CFD-beregninger
3) Opbygning af model
4) Den valgte struktur
5) Model for CFD forberedelse
6) Udfordringer til fleksibiliteten
7) På vej mod integration
8) Konklusion

Referencer

Baggrunden for arbejdet

Winning cars from 2015 Shell EcoMaraton Europe

[Ref. 1,2 og 3]]

Battery-electric

Technische Universitaet Muenchen
TUFAST ECO TEAM - 863km/kWh
(a)

Alternative fuel

Universitat Miguel Hernandez D'Elx
EQUIP UMH – 1496 km/l
(b)

CNG

Lycee Saint-Joseph La Joliverie
MICROJOULE-LA JOLIVERIE - 2584km/l
(c)

Diesel

I.U.T Valenciennes
IUT GMP VALENCIENNES - 1323km/l
(d)

Gasoline

Airbus Helicopters Centre de Formation Technique
TED - 2308 km/l
(e)

Hydrogen

Delft University of Technology
ECO-RUNNER TEAM DELFT- 1227 km/m³
(f)

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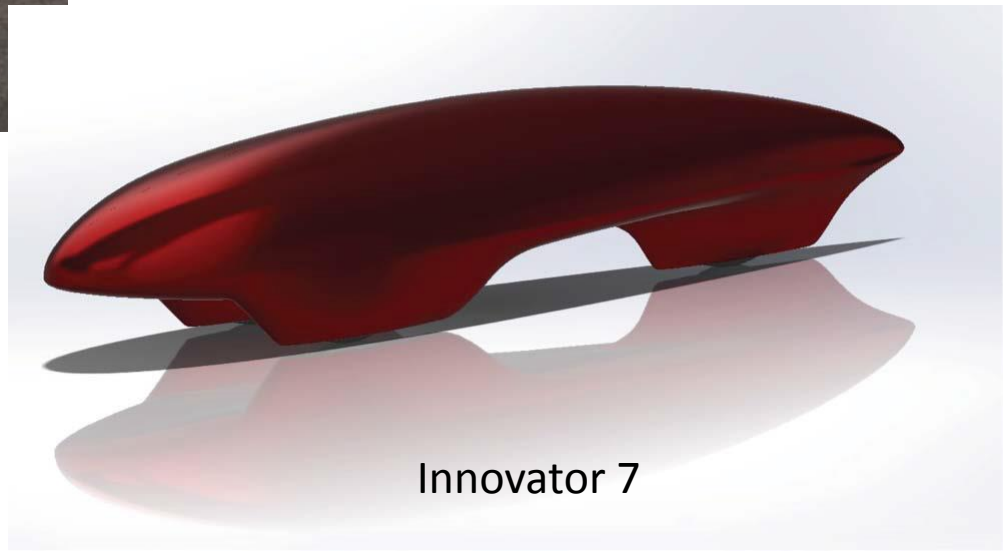
DTU fra Innovator6 til Innovator7

Innovator 6



Innovator 7

[ref. 3]

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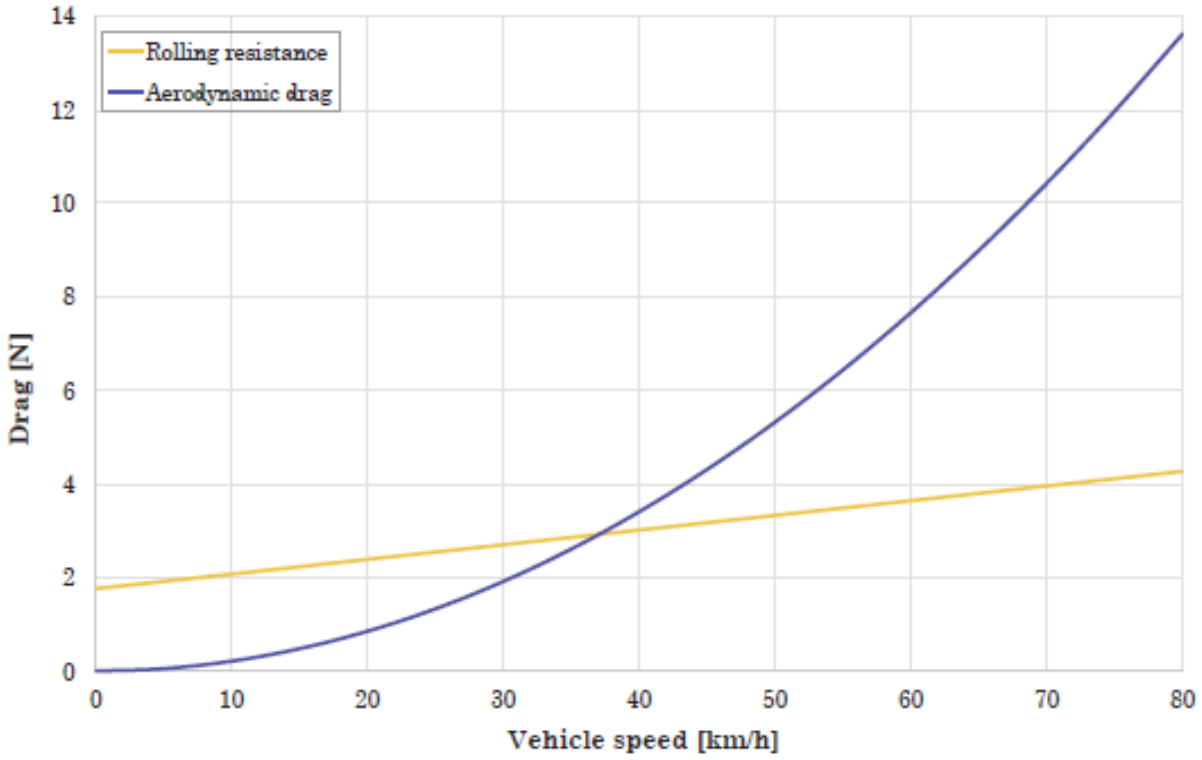
Flowmodstand for Innovator



Aerodynamic drag and tire rolling resistance as function of vehicle speed.
CD · A=0.045m2, W =765N, Crr1=0.0023 and Crr2=4.1·10−5 (km/h)−1 [ref. 3]

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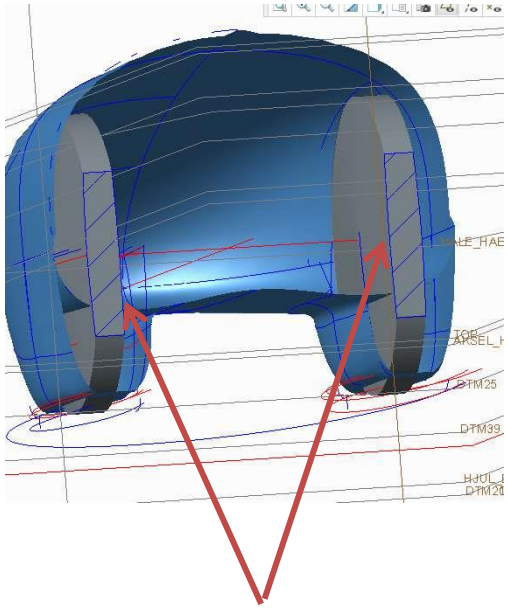
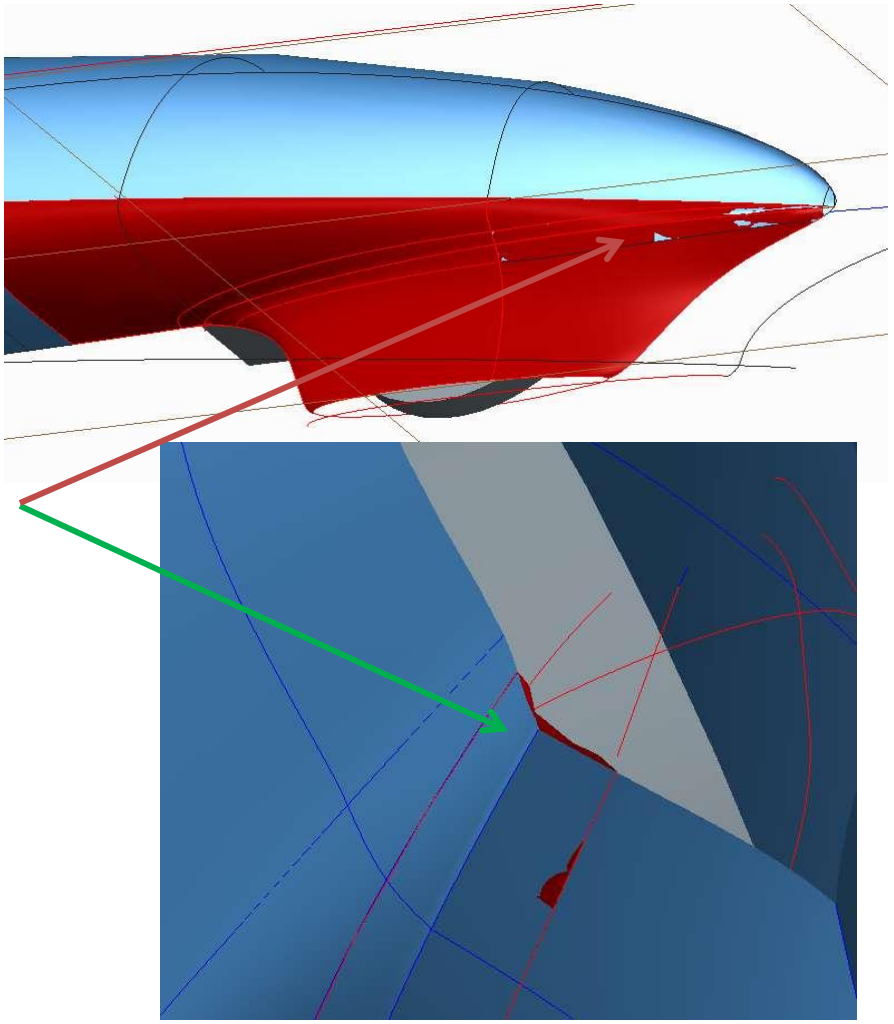
Problemer med surfaces (ISDX-style)





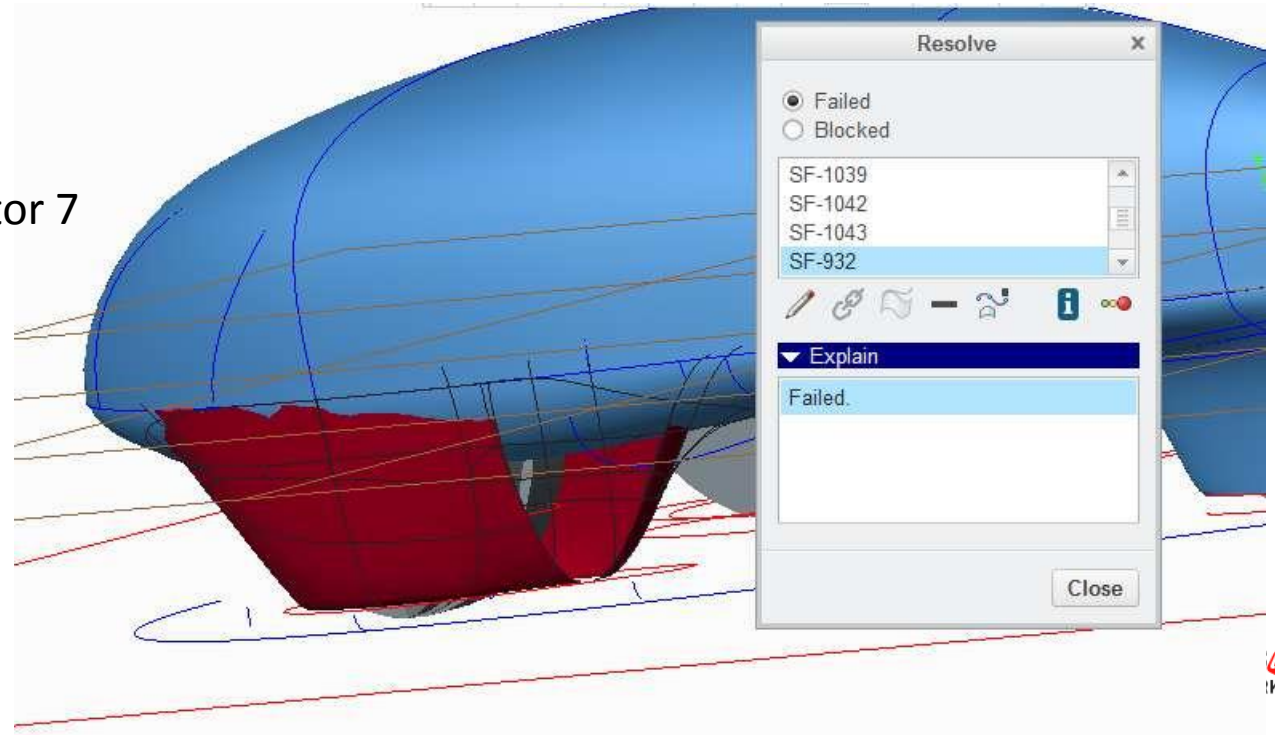
- Overlappende flader – forhindrer at lave tykkelse eller solid-modeller

Problemer med regenerering af surfaces (ISDX)

Regenererings vanskeligheder

(alt i én Style)

Innovator 7



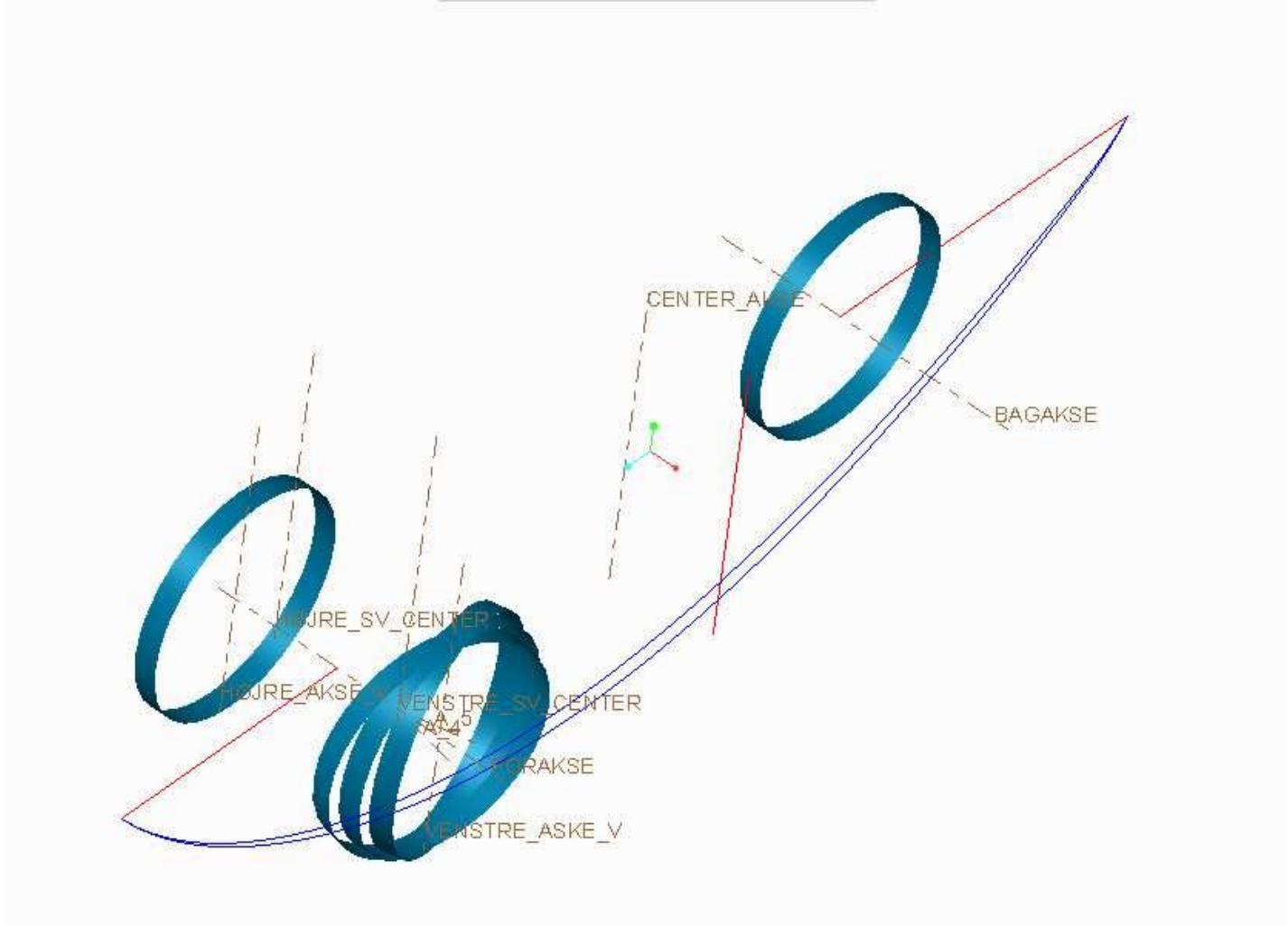
Strategi for modelleringen

1) Undgå at lave alt i én STYLE
2) Style 1) Hovekroppen i én STYLE med så få og store flader som muligt hovedkroppen skal have en god nok kvalitet til at kunne skabe tykkelse eller lave solid body.
3) Style 2) Hjulkasser foran laves i venstre side og spejles der tilstræbes størst mulig robusthed og fleksibilitet, som muliggør ”fuld” integration med main body. Kasse lukkes og laves solid.
4) Style 3) Hjulkasse bagest laves kun en ½ kasse laves pg.a. symmetri. Kasse lukkes og laves solid.

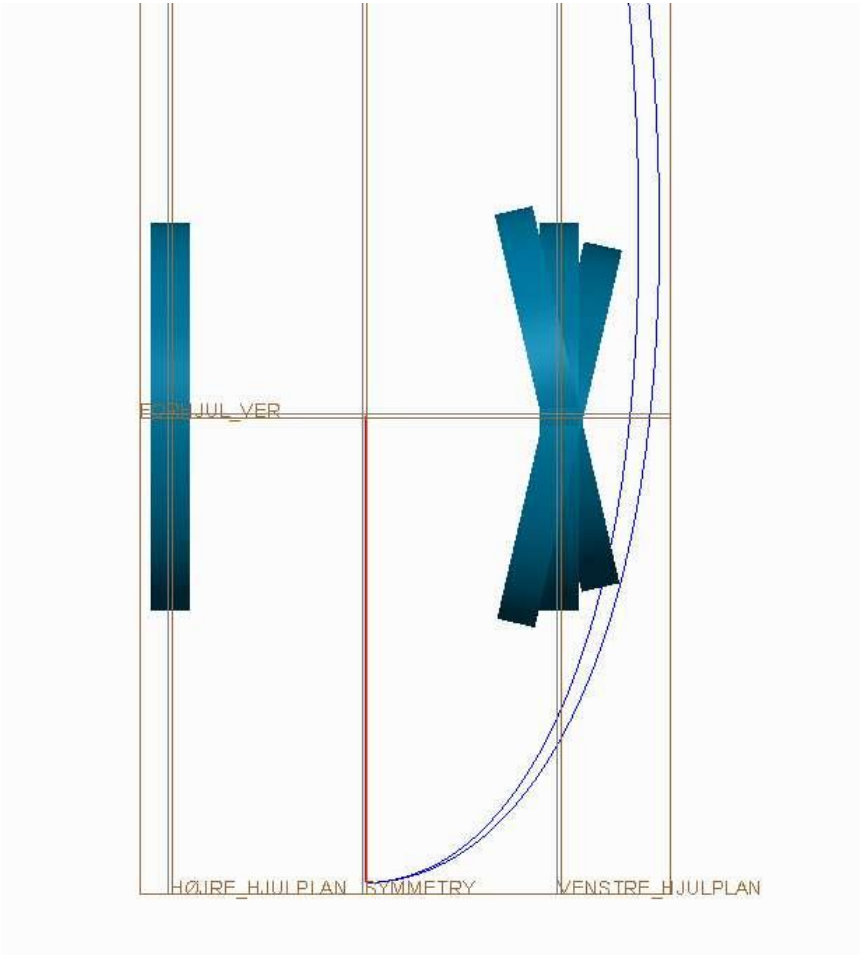
Style nr. 1 Main body

- Referencer svarende til hjulakseplaceringer, min. Chaufførhøjde, hjulstørrelser og hjuldrejning indsættes. Horizontelt plan gennem hjulakslerne og plan for tætteste afstand mellem bil og underlag (SKØRT)
- En langsgående NACA kurve importeres og billeder fra den optimerede Innovator 7 model indlægges og skaleres til den nye totallængde: 2800 mm
- (se næste slide)

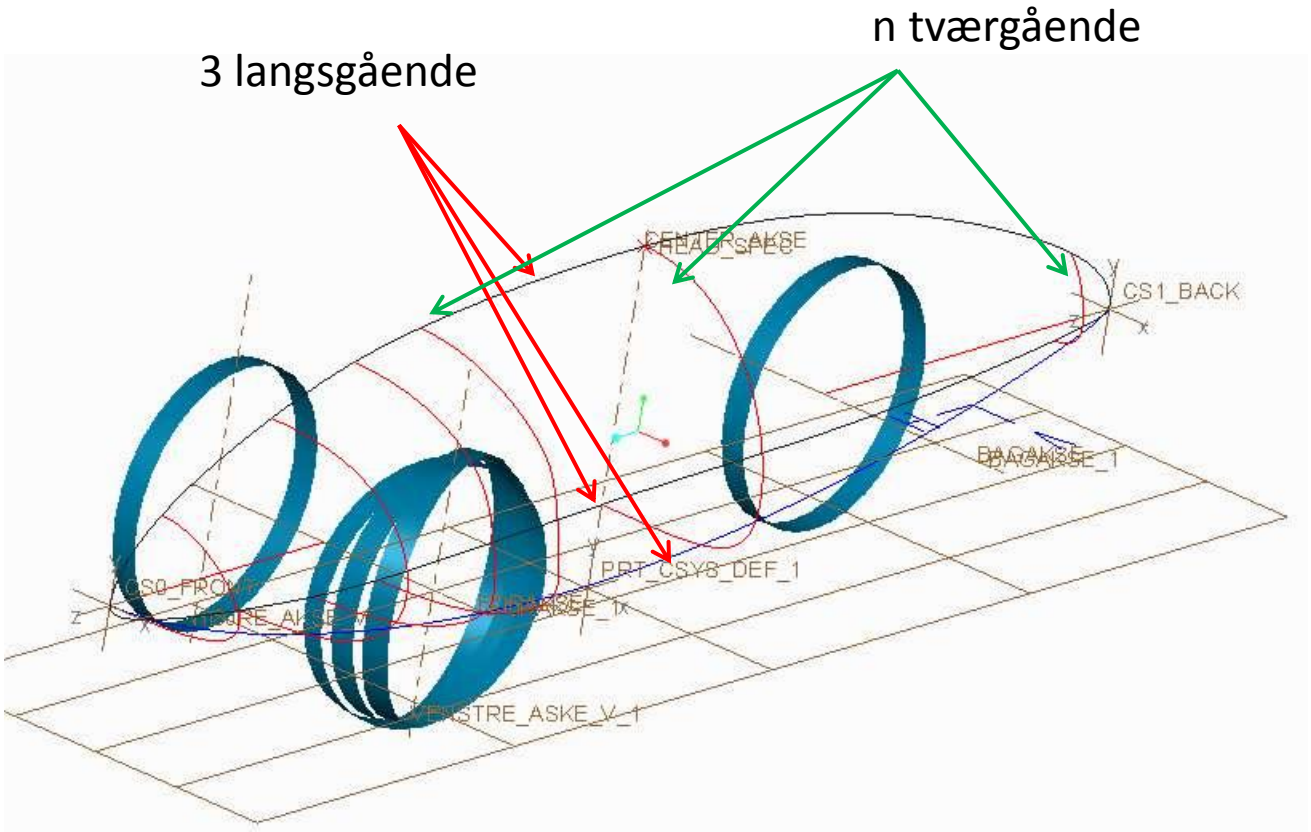
Hoved referencer



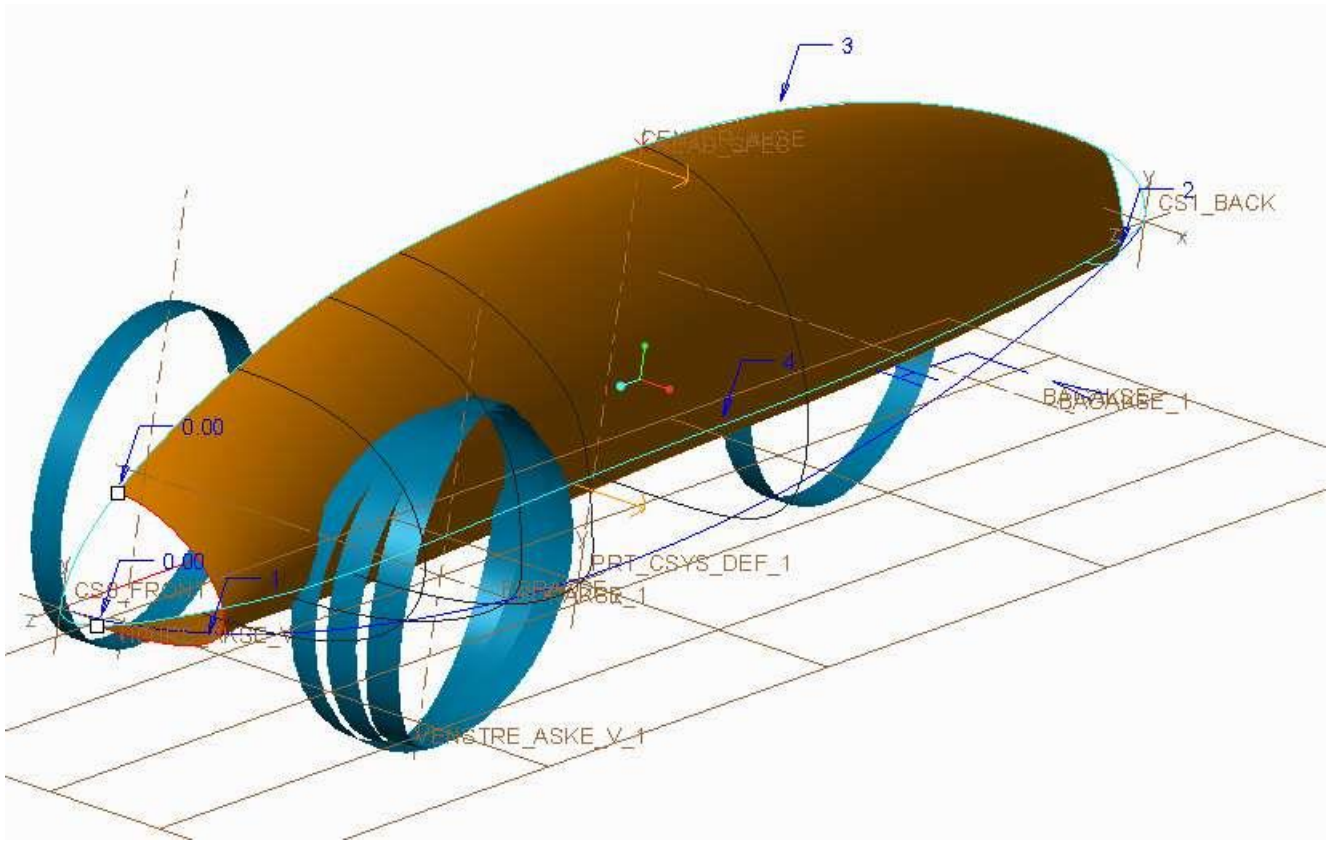
Import af ændret NACA curve (7% bredere))



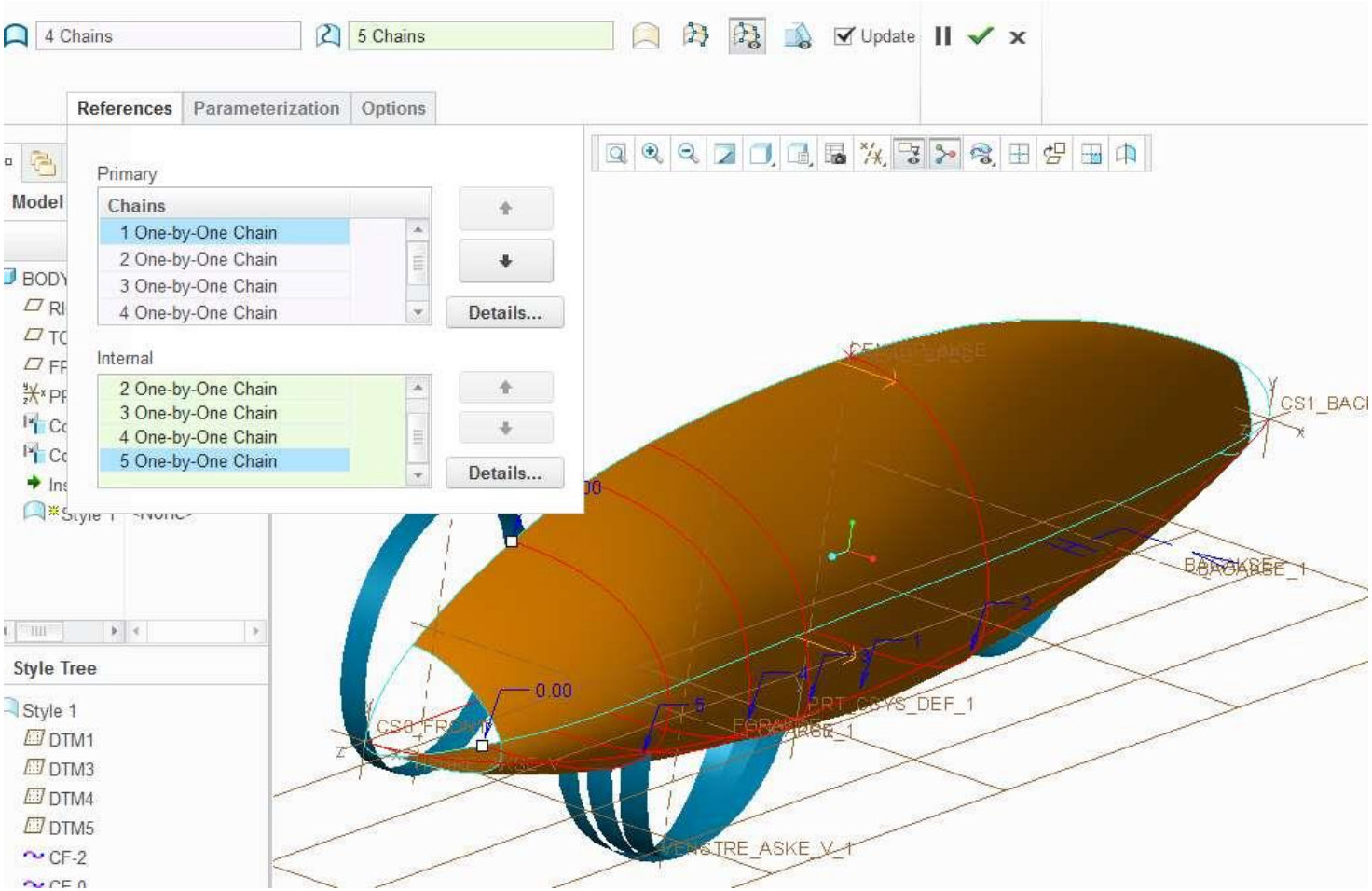
De bærende STYLE kurver



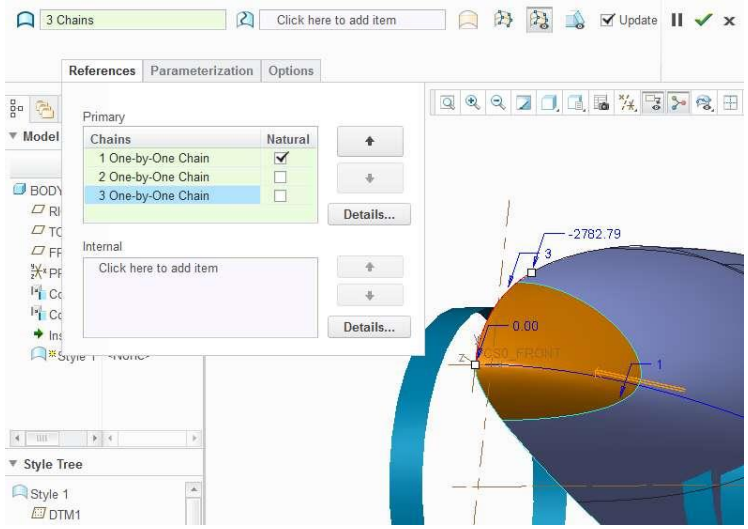
Hoved surface (så stor som muligt)

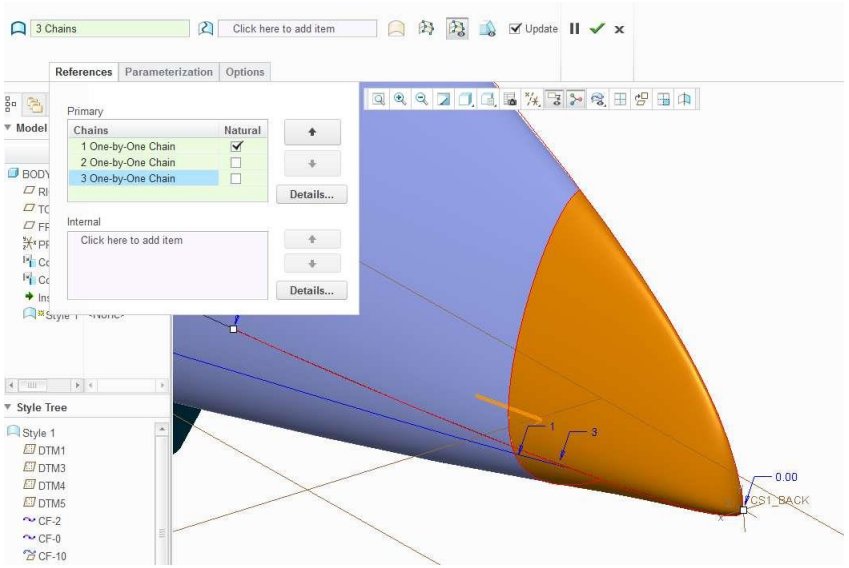


Justering af hoved surface via ”internal curves”

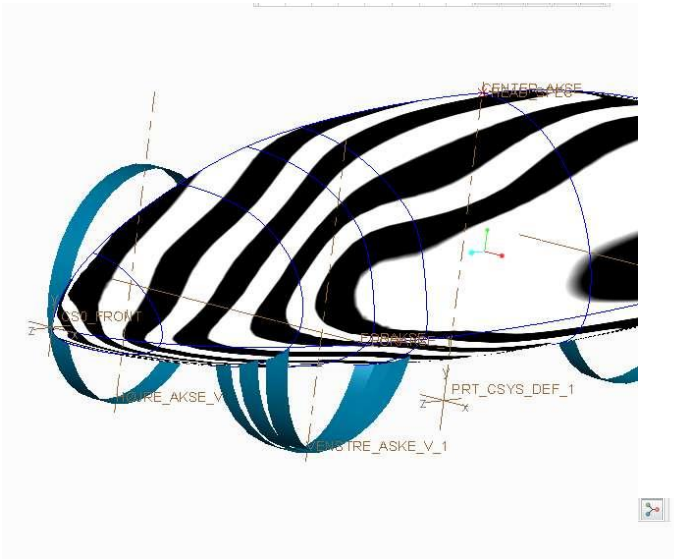


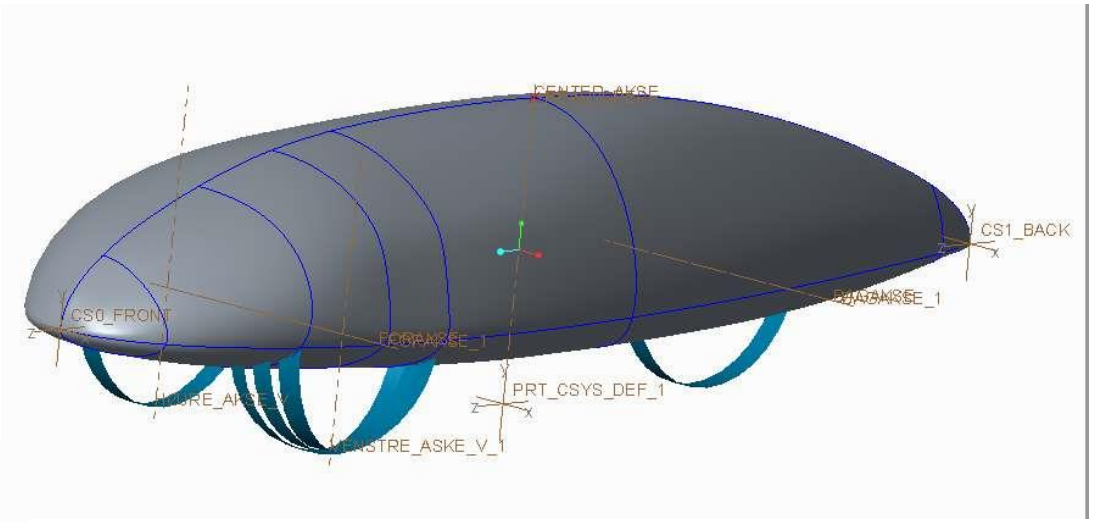
Trekanter – når vi har lidt travlt

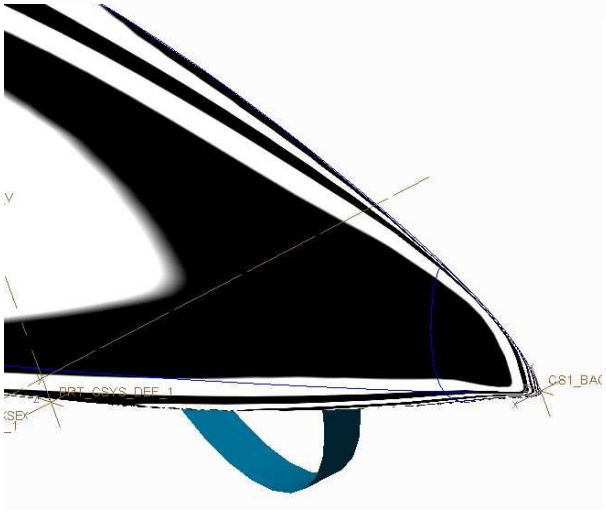




Refleksions check

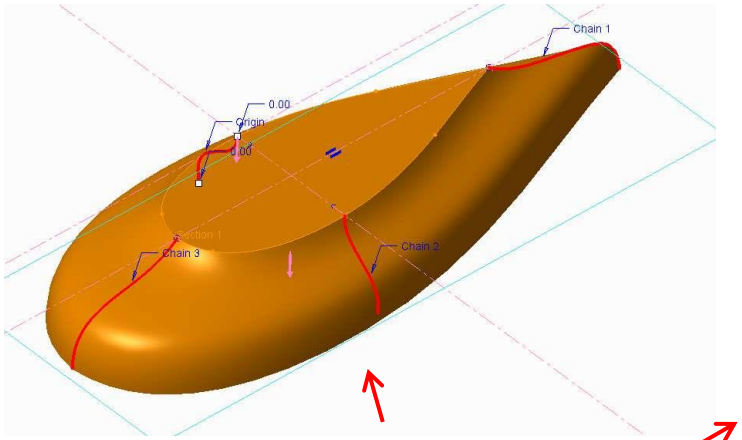






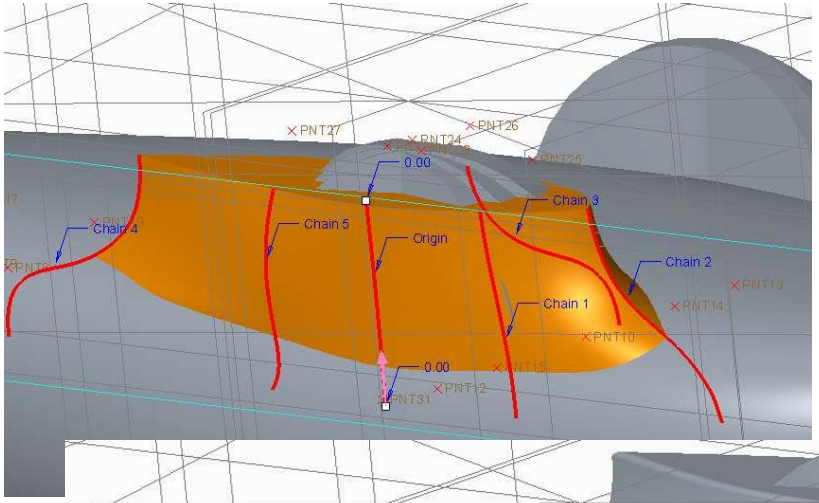
Solid Main body

Indledende modelforsøg med hjulkasser: Sweep

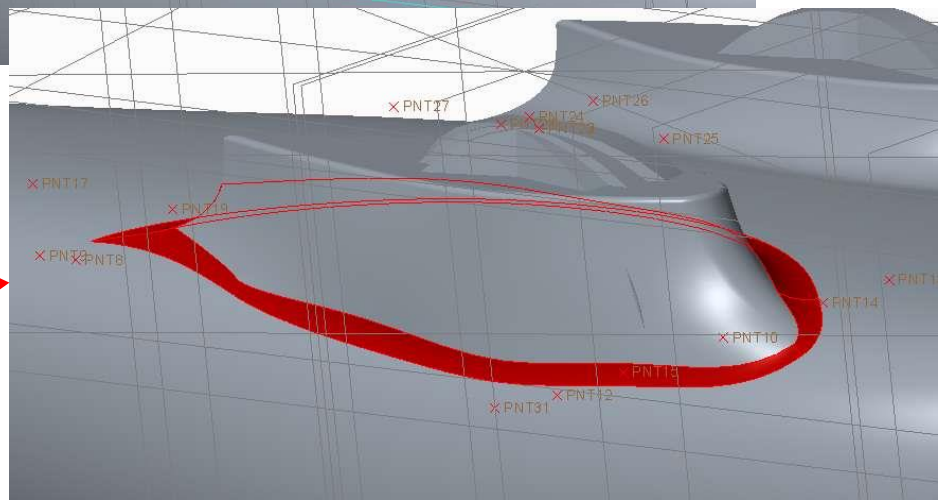


Første test OK

Implementering



Afslut med runding



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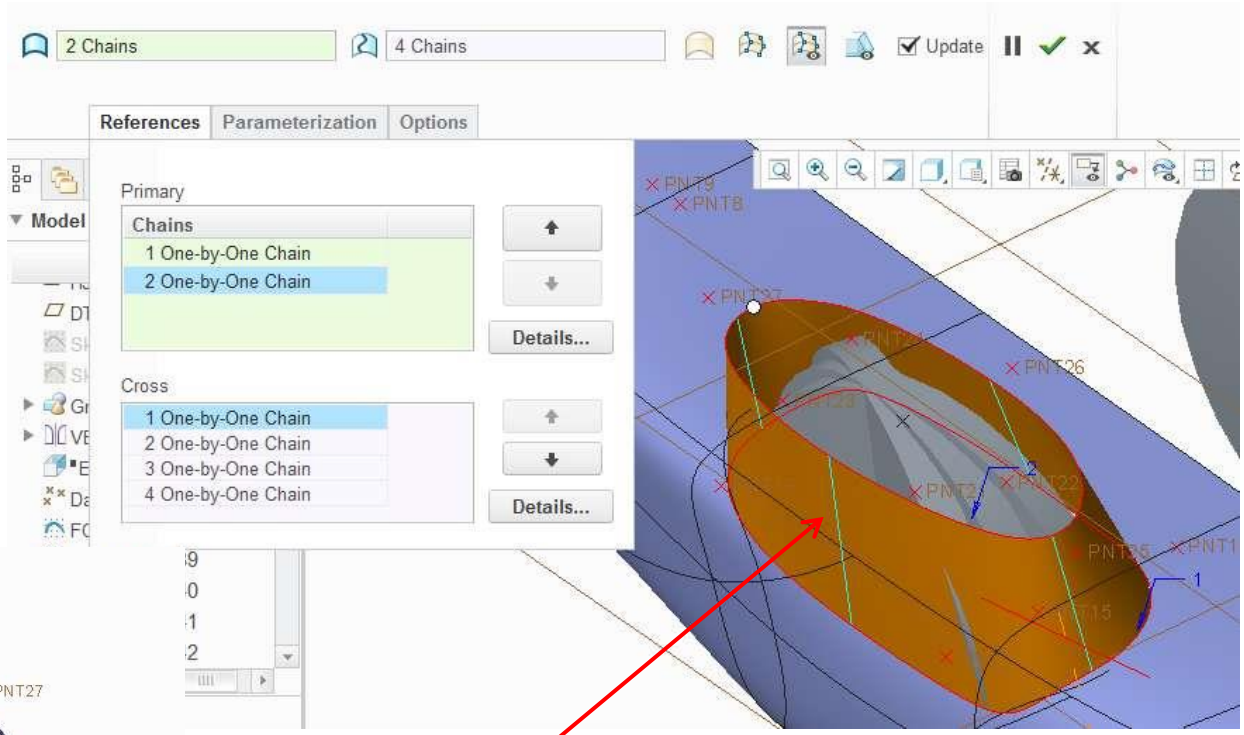
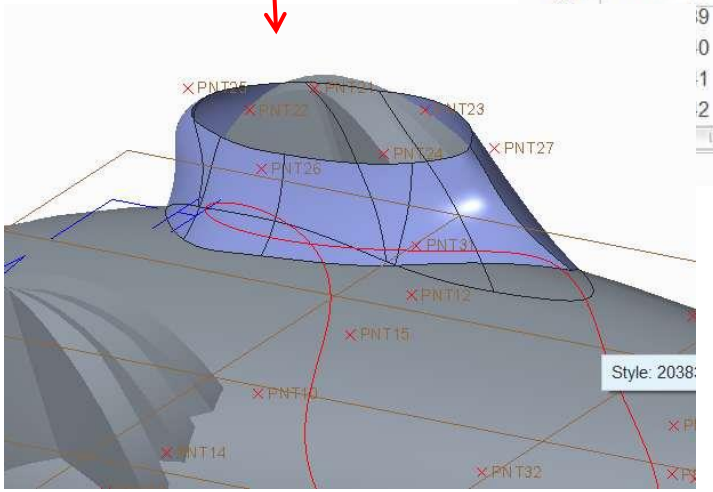
Indledende forsøg med STYLE hjulkasser

Flader langt vanskeligere at Styre end først antaget - Specielt ved projicerede eller sammenhængende kurver





En slags ”STYLE-blend” med hele lukkede Kurver virker, men overgangen til body?

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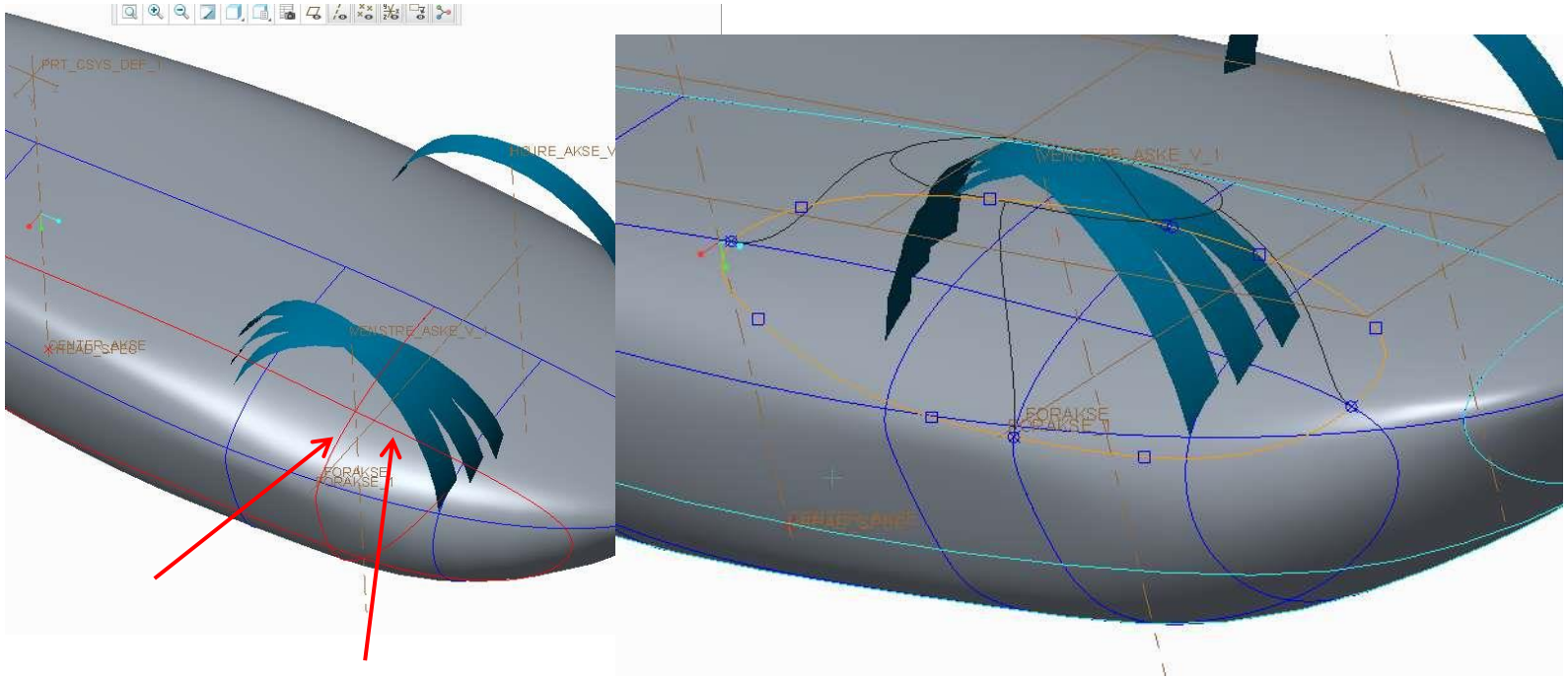
Den valgte løsning for forreste hjulkasse



Intersections af Body og DATUM planer

Curve on Surface (COS)

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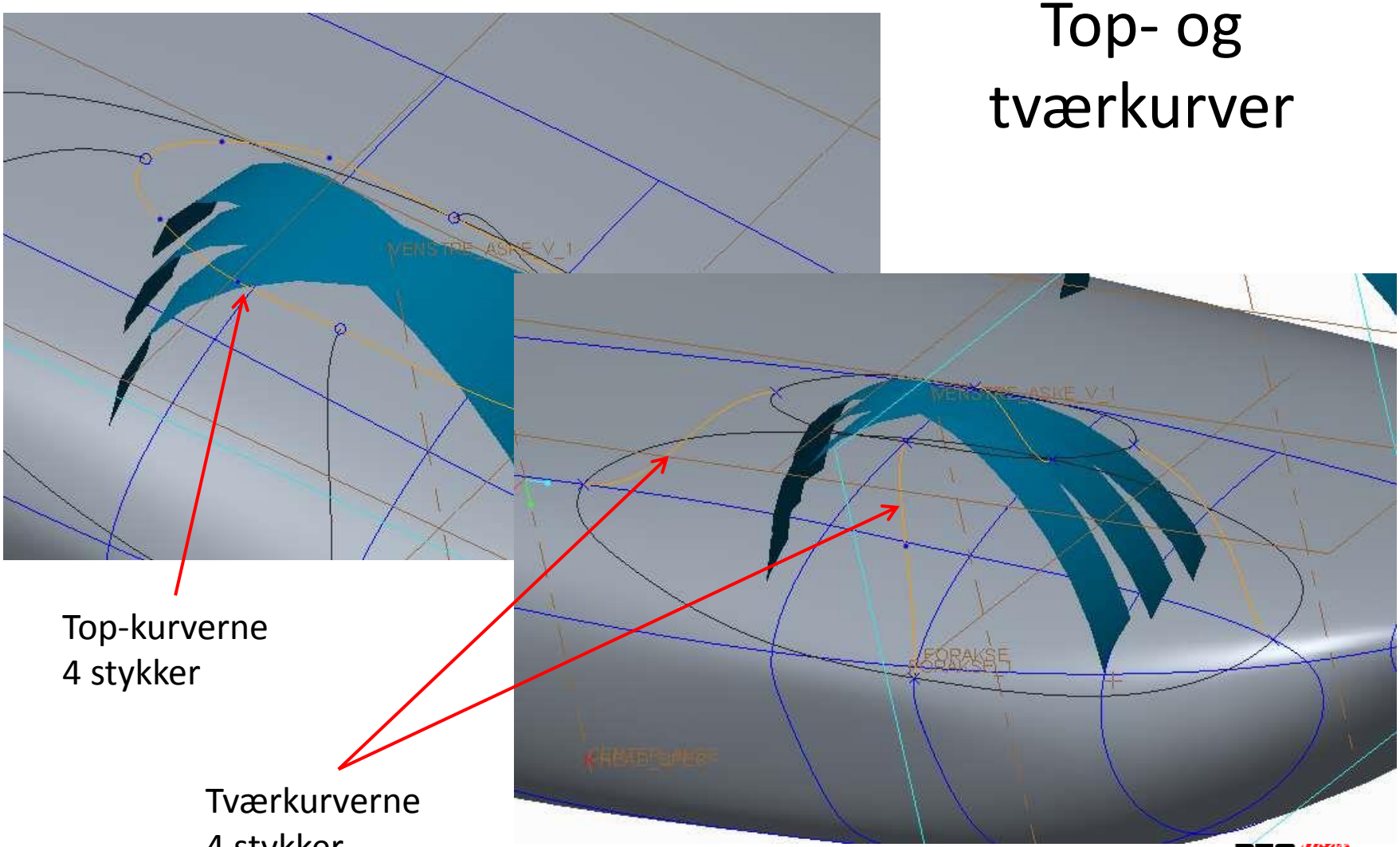
4-delt hjulkasse

Top- og tværkurver



Top-kurverne
4 stykker

Tværkurverne
4 stykker

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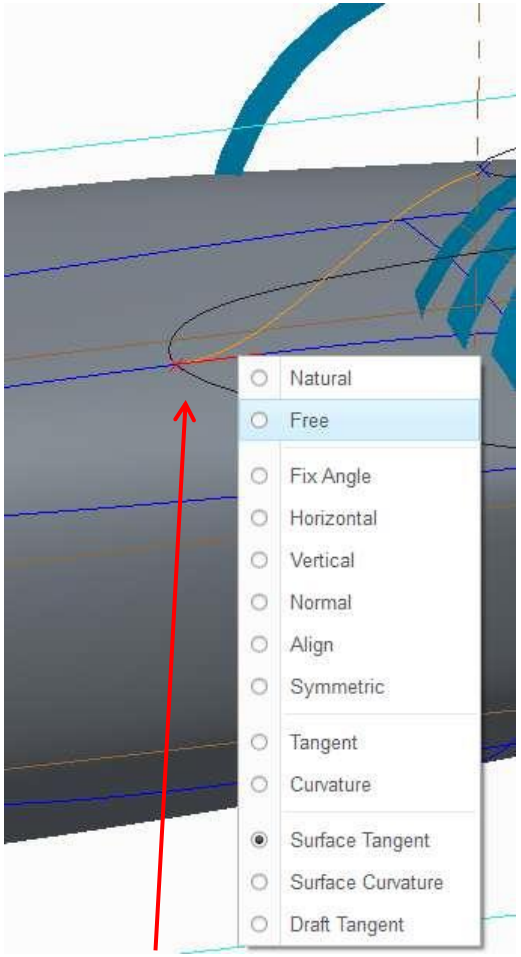
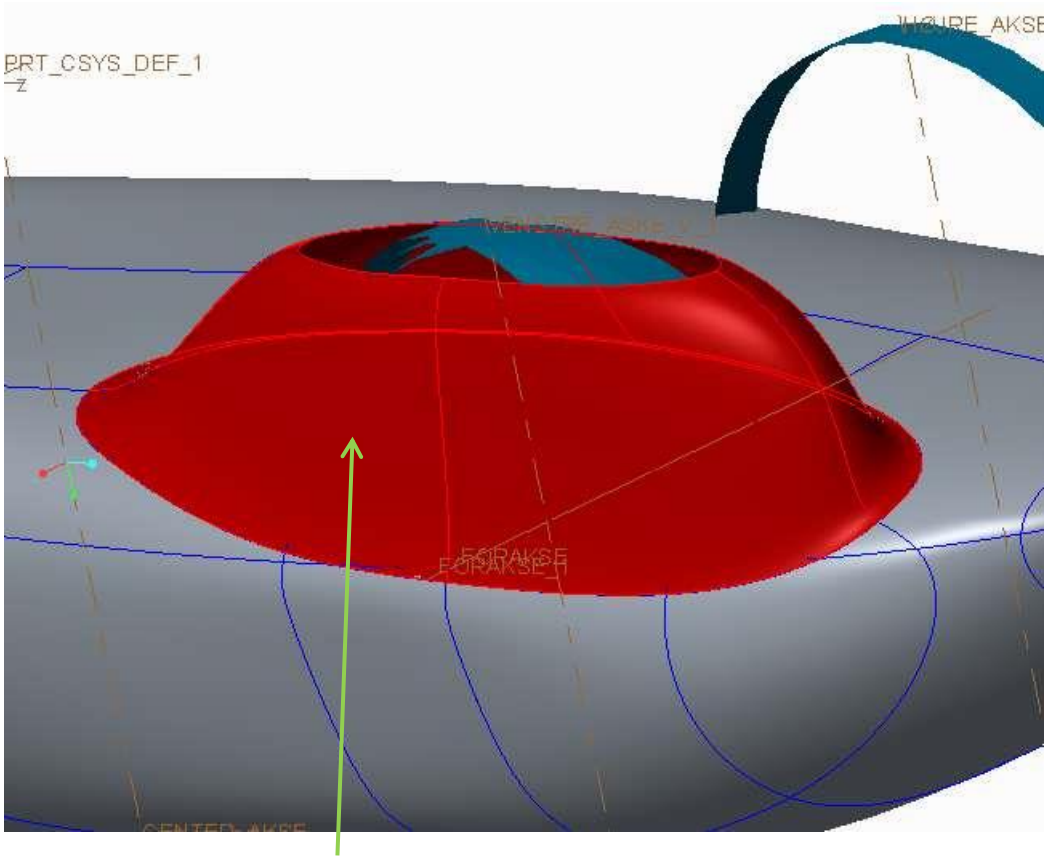
Fire flader med blød overgang til Body



Tværkurver styrer overgang til Body



Fire flader indsættes

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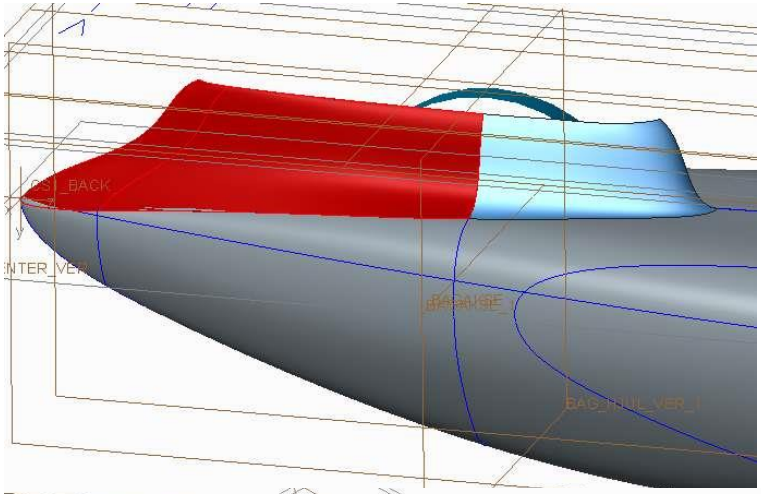
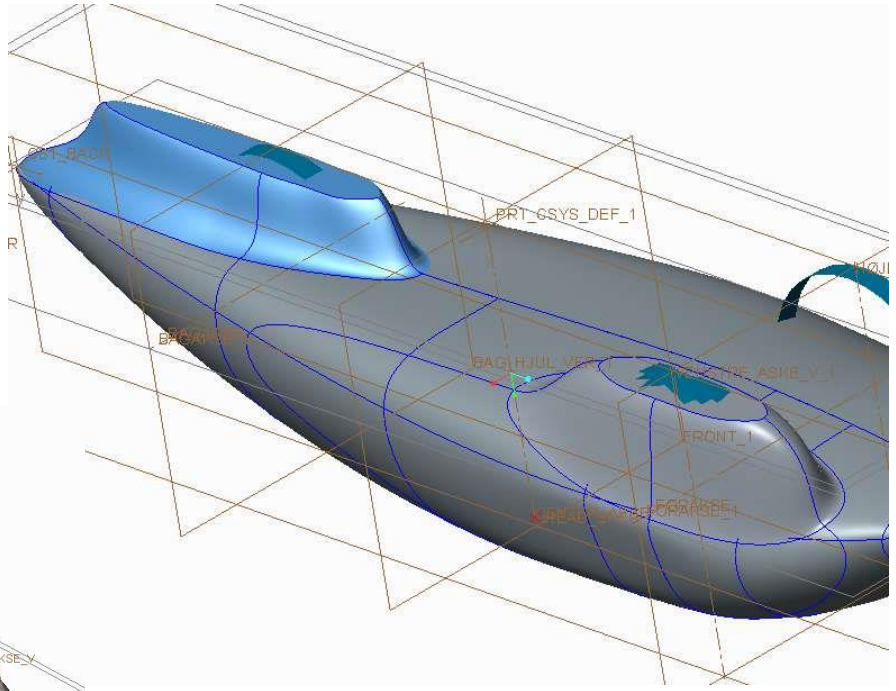
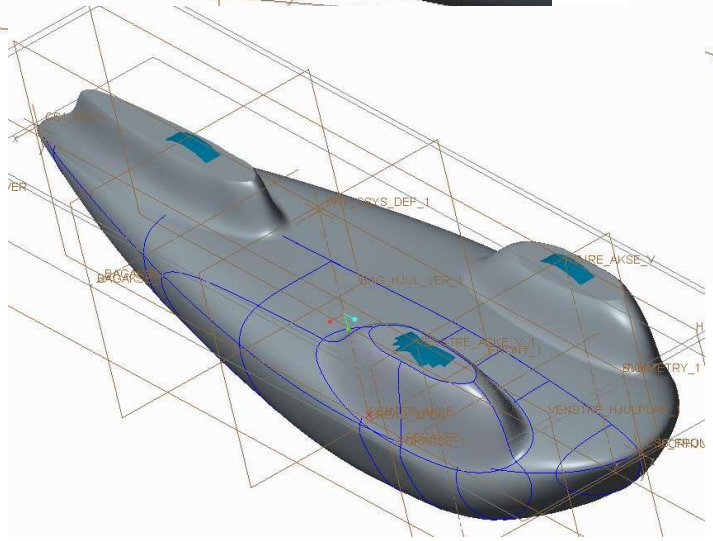
Hjulkasse for baghjul og fill/solidify







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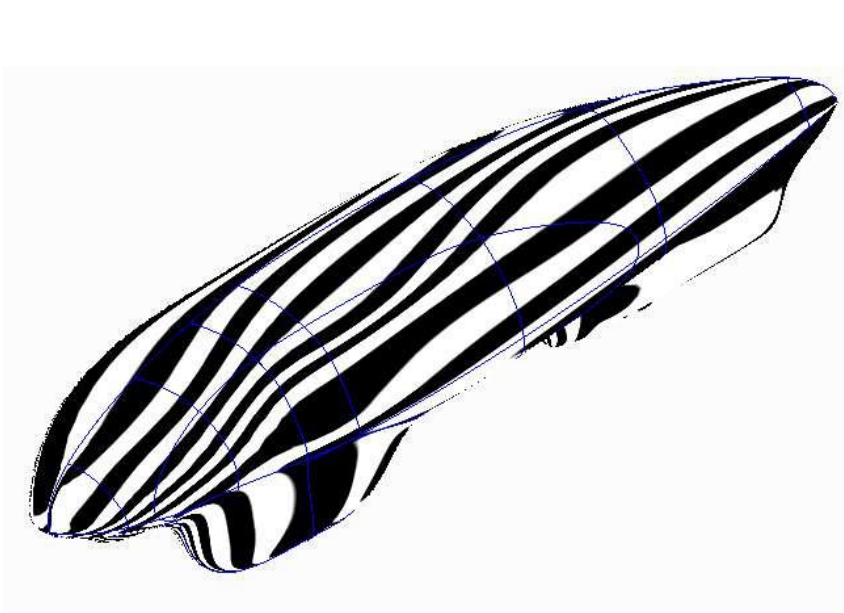
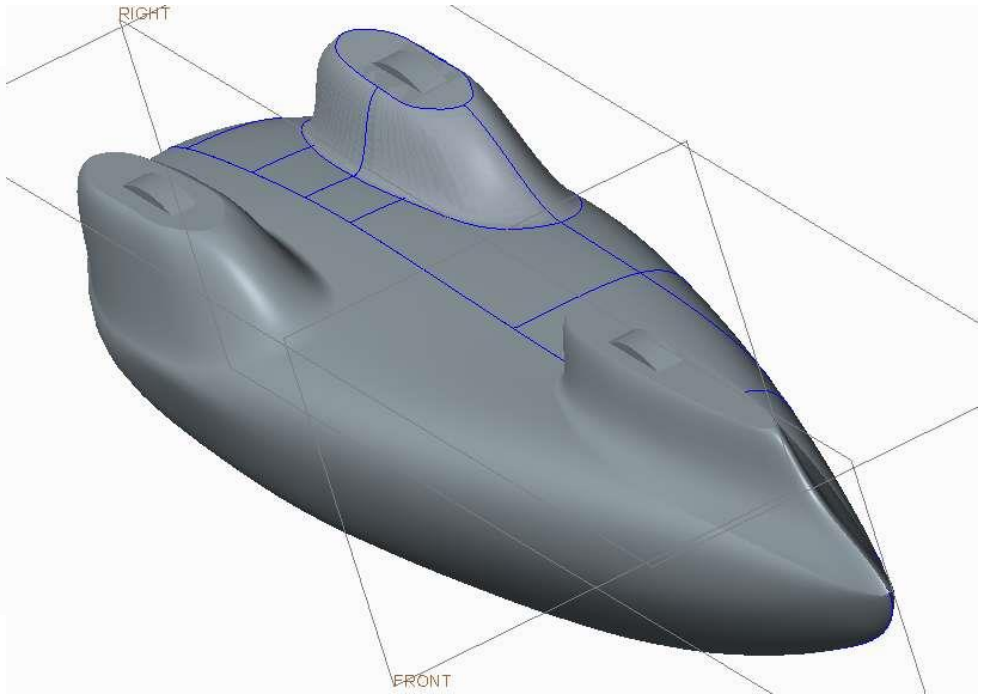
Refleksionscheck og solide hjul





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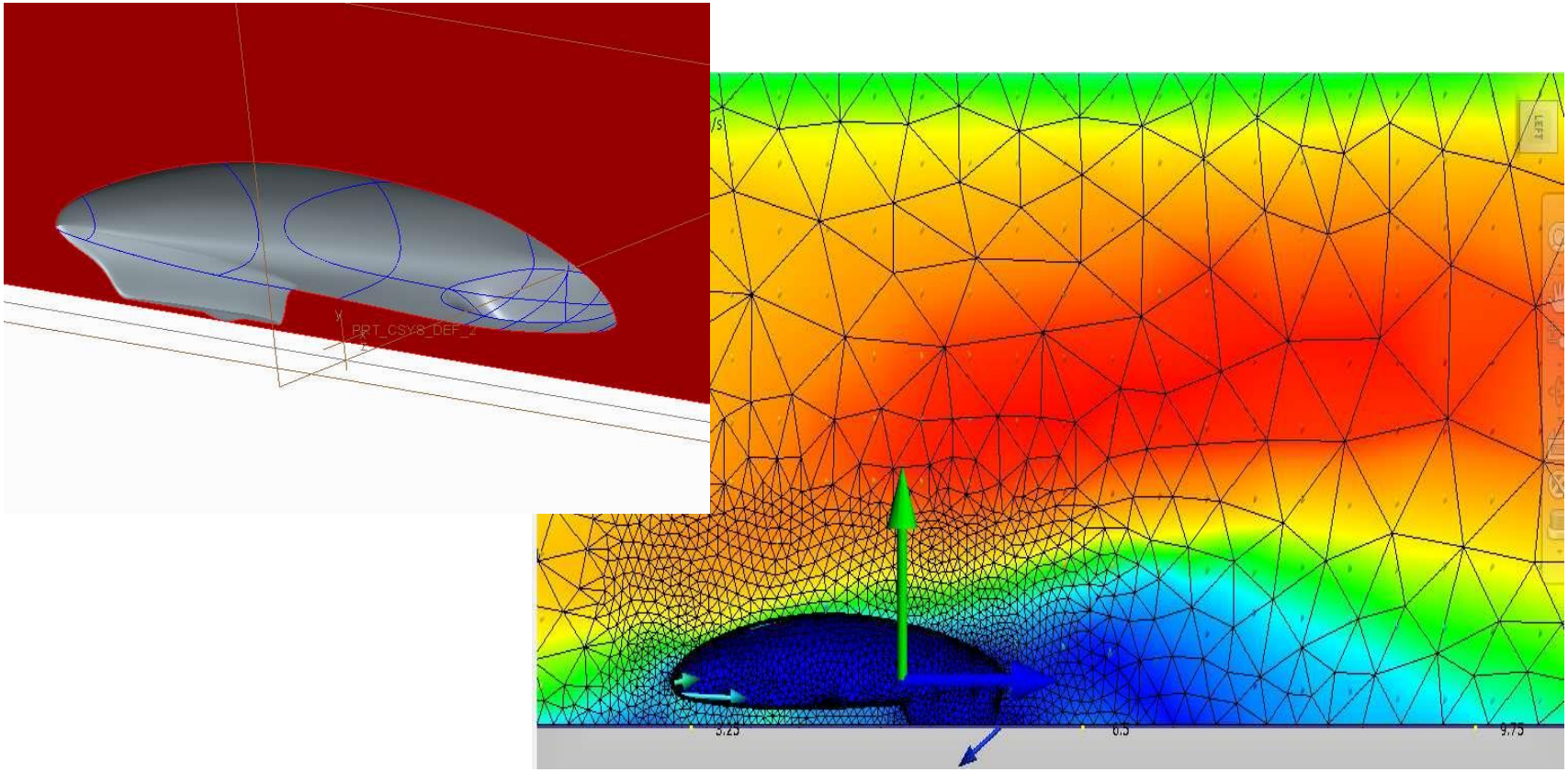
Model for CFD-beregninger import til CFD Design via STEP-fil



CFD Design Autodesk [ref.7 gkch]

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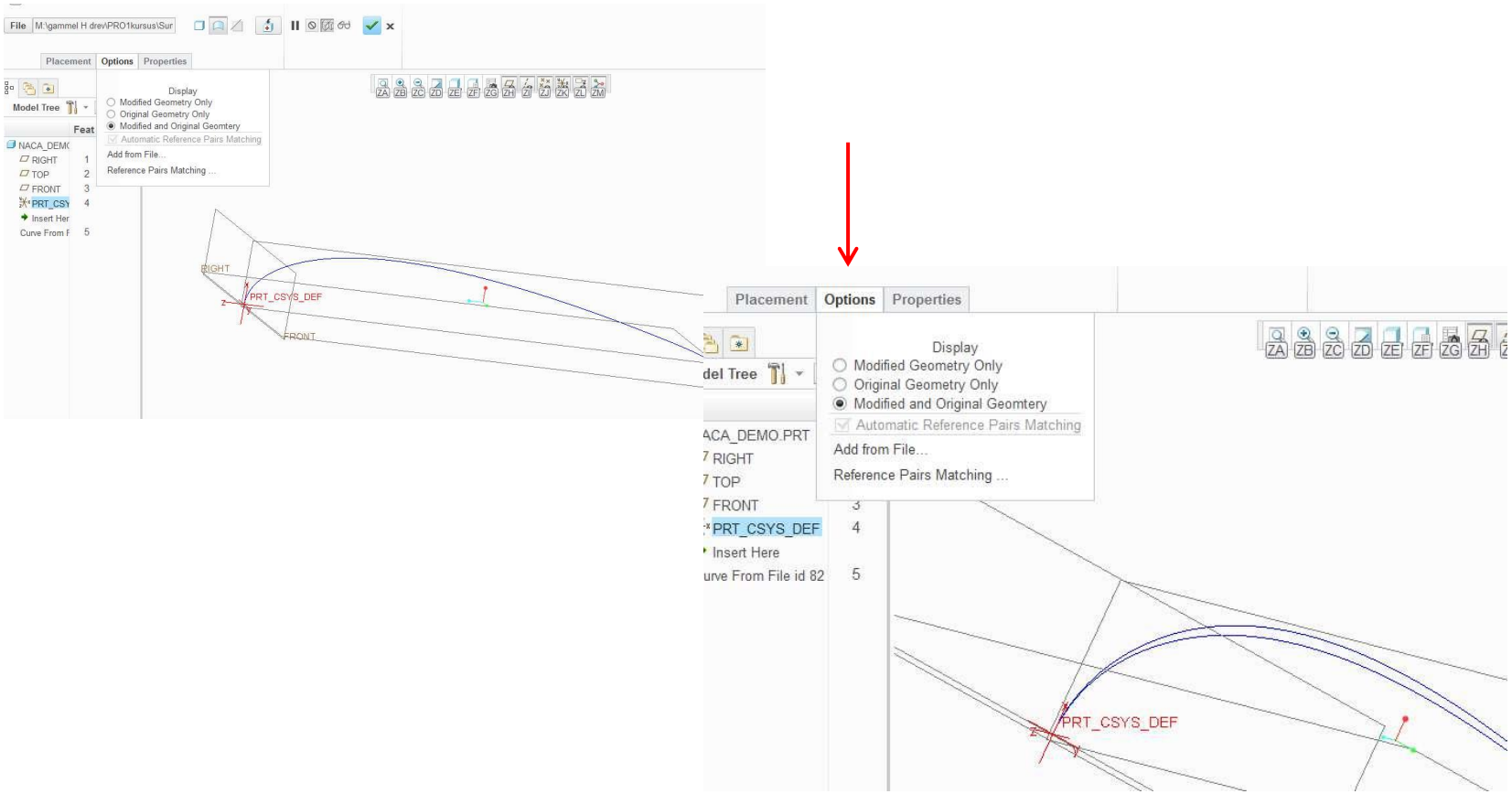
Fleksibilitet ?
Design ændringer via NACA-curver ?



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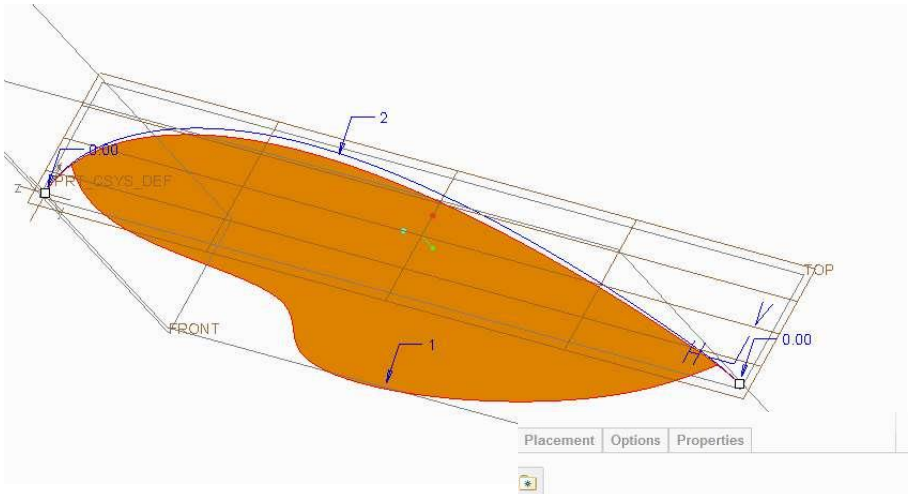
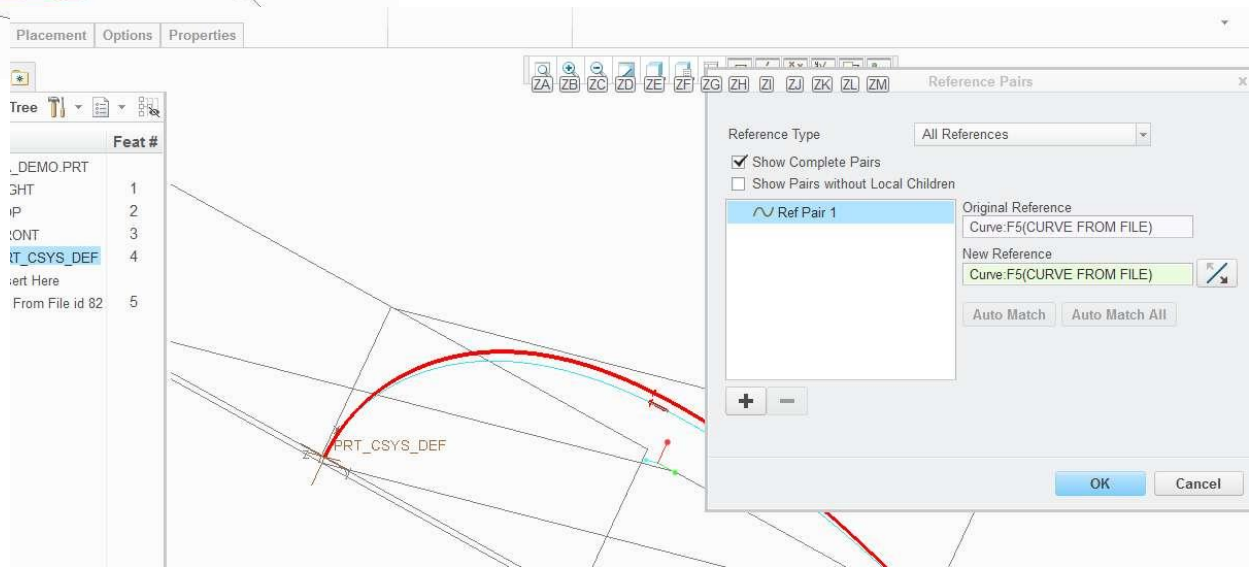
Fleksibilitet ved importerede curver





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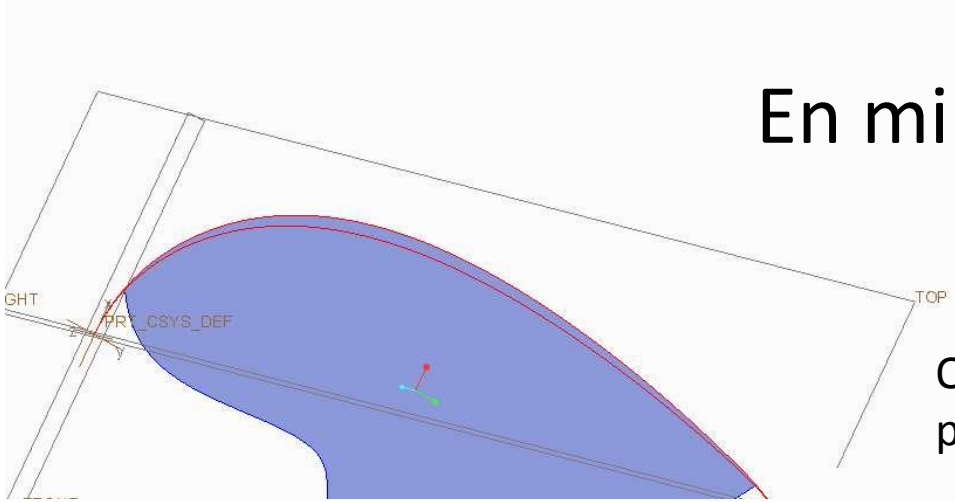
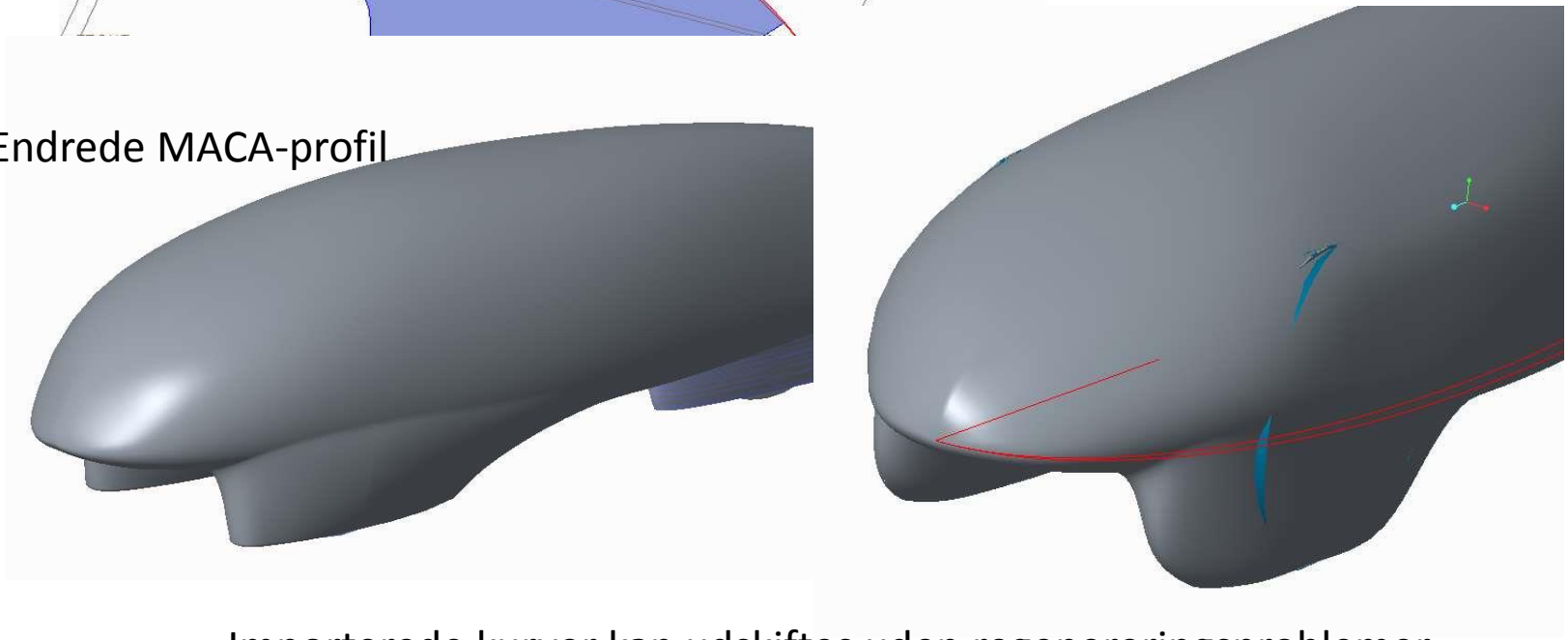
En milepæl er nået !!!



Oprindelige NACA-profil

Ændrede MACA-profil



Importerede kurver kan udskiftes uden regenereringsproblemer

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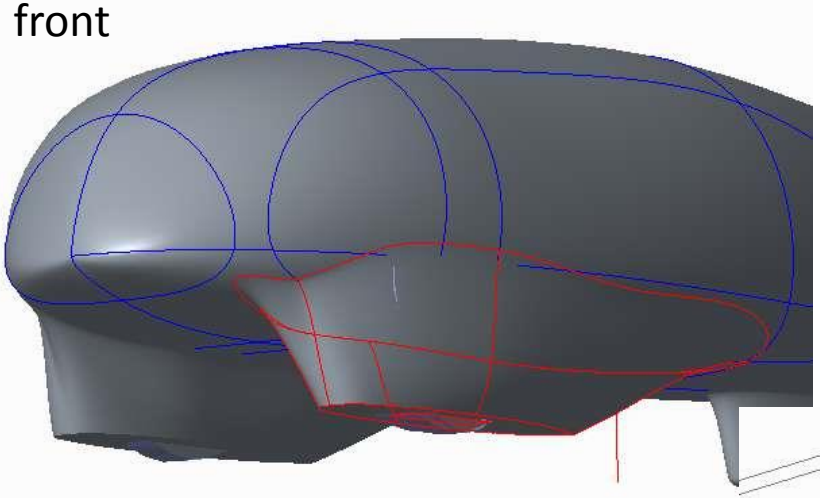
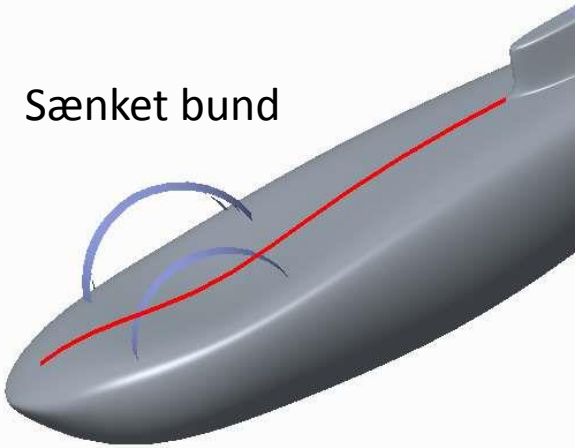
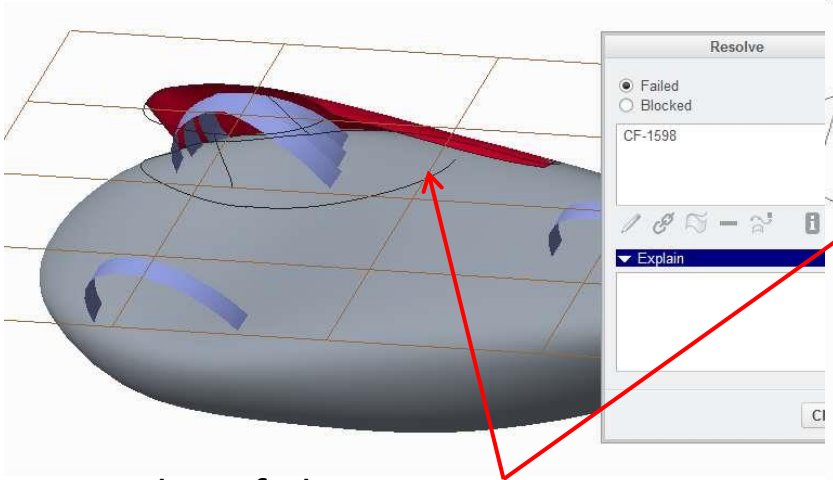
Den øvrige fleksibilitet ?

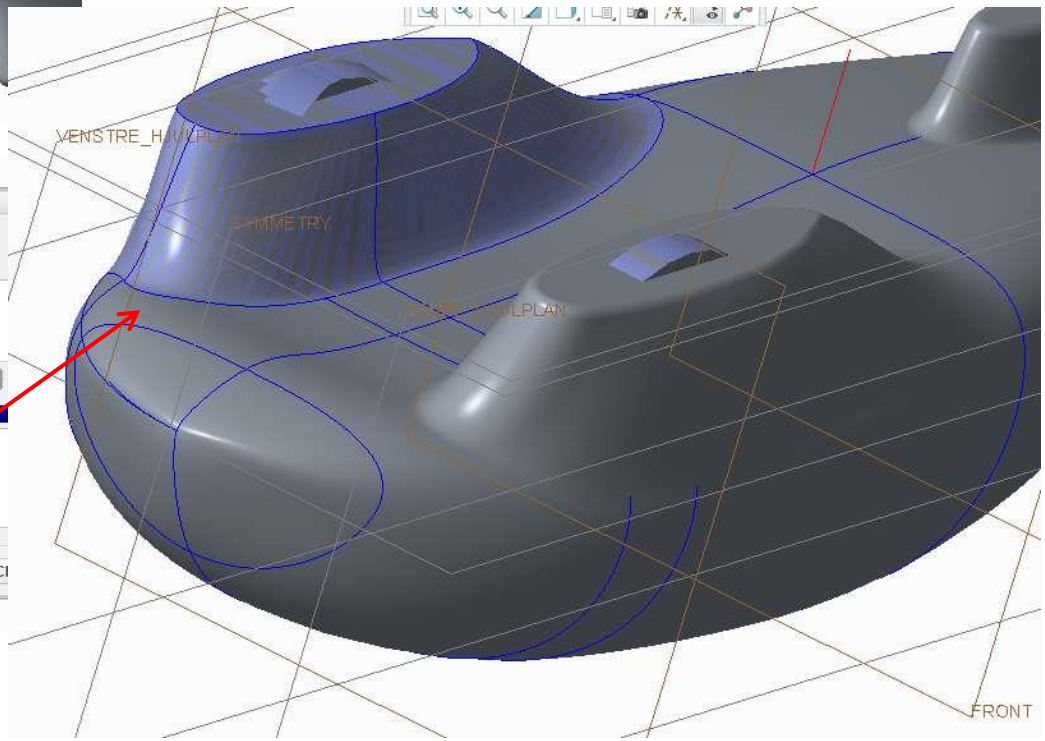
Hævet front



Sænket bund

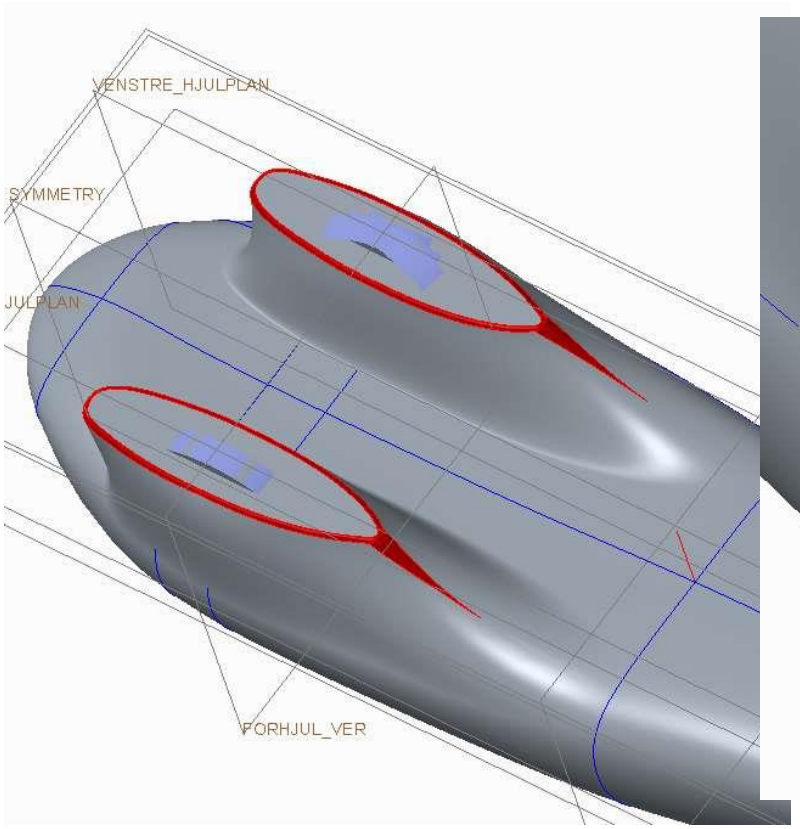




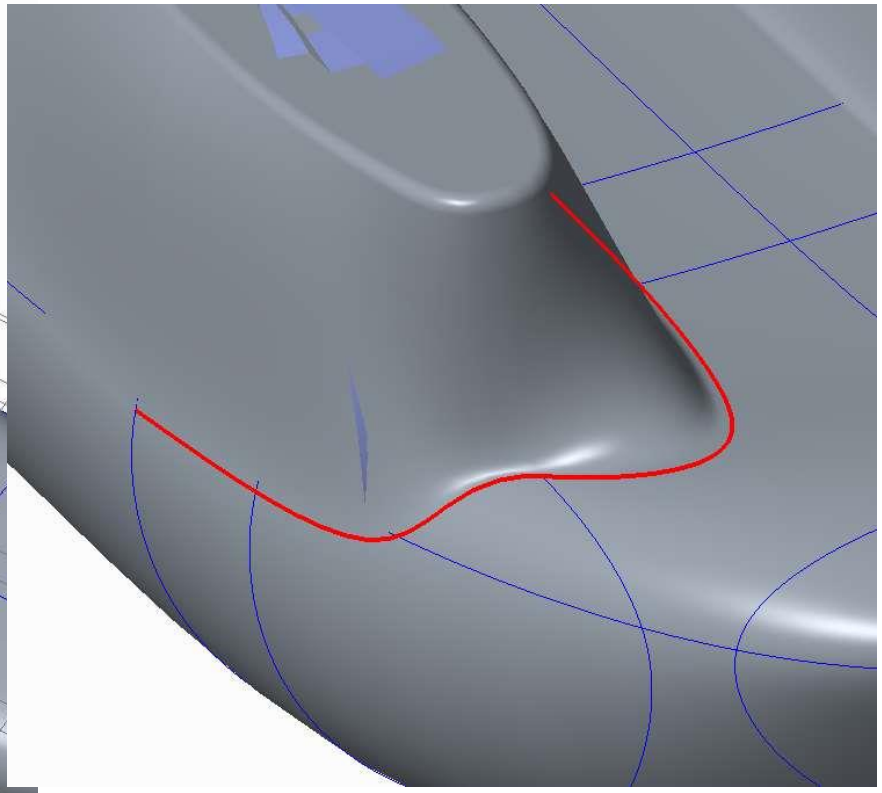


Fejl- og fejlretning

Mindre ændringer kan være påkrævede !



Nye rounds ved hjulkasser



Justering af COS

DEMO

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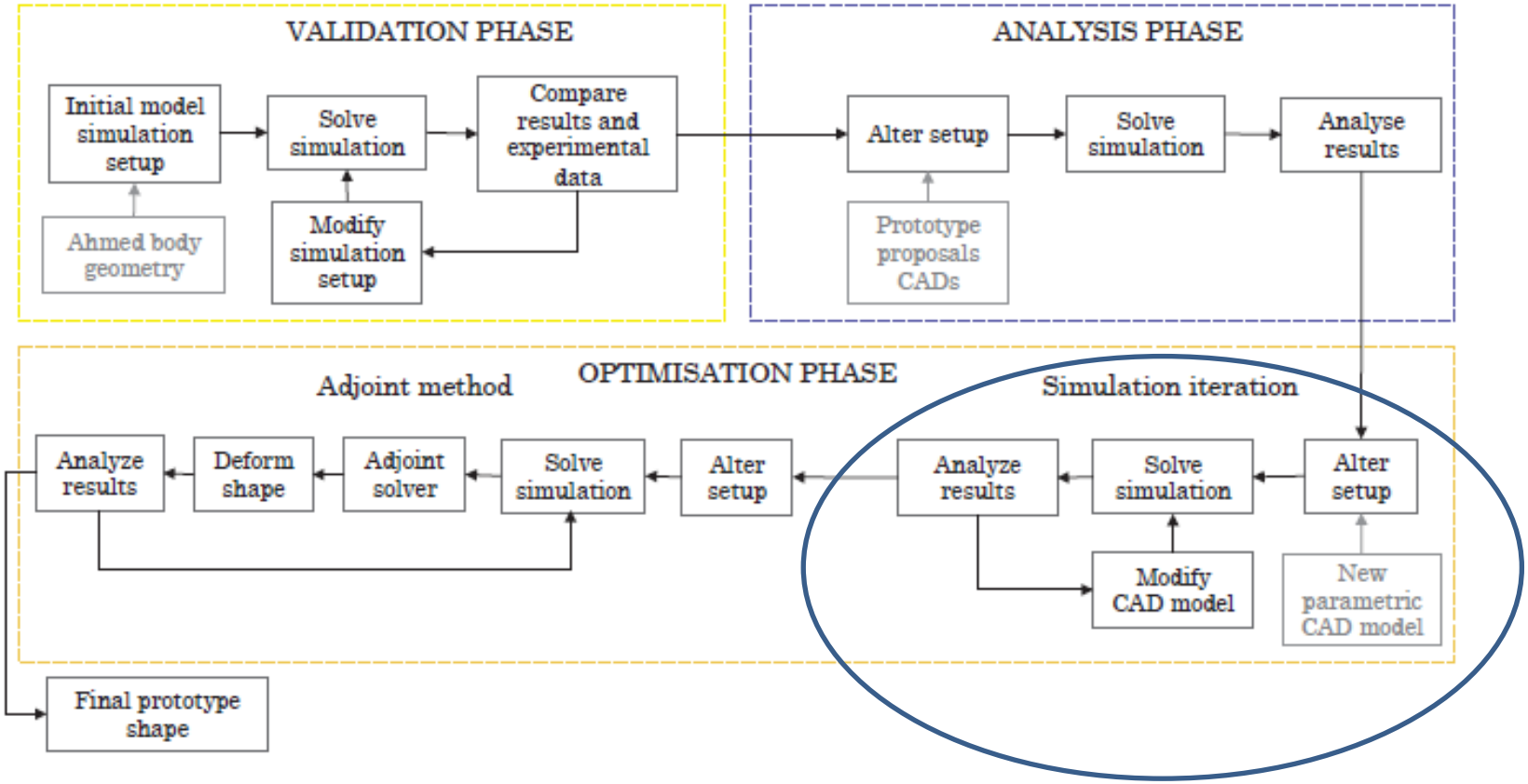
Interface ?


VALIDATION PHASE
Initial model simulation setup
Solve simulation
Compare results and experimental data
Ahmed body geometry
Modify simulation setup
ANALYSIS PHASE
Alter setup
Solve simulation
Analyse results
Prototype proposals CADs
OPTIMISATION PHASE
Adjoint method
Simulation iteration
Analyze results
Deform shape
Adjoint solver
Solve simulation
Alter setup
Analyze results
Solve simulation
Alter setup
Modify CAD model
New parametric CAD model
Final prototype shape

Konklusion

- Det lykkedes at skabe en model som kan modstå mindre ændringer – sandsynlige i forbindelse med CFD-optimeringer
- Mulighed for ”smertefri” opdatering af importeret geometri åbner mulighed for i højere grad at basere designet på NACA-profiler og lignende
- Der savnes dog et link fra CFD-optimeringen og tilbage til CREO 3.0 – dette må p.t. gøres manuelt
- Måske kan noget løses via ”Reverse Engineering” hvor en punktsky konverteres til STYLE-surfaces?

Referencer m.v.

Reference 1: private conversations with: Sigurd L. Ildvedsen and other Eco team members

Reference 2: http://www.shell.com/global/environment-society/ecomarathon.html (accessed 21. of January 2016).

Reference 3: Neus Mesalles Teixidó "CFD analysis and optimization of aerodynamics on a fuel efficient vehicle", Juli 2015, DTU Mekanik.

Reference 4: https://upload.wikimedia.org/wikipedia/commons/thumb/3/37/14ilf1l.svg/220px-14ilf1l.svg.png (accessed 19. of January 2016)

Reference 5: NACA airfoils at: http://airfoiltools.com/airfoil/details?airfoil=naca0015-il (accessed 21. of January 2016).

Reference 6: private conversation with: Professor MSO: Jens Honore Walter, DTU Mekanik

Reference 7: "Autodesk Simulation CFD 2015"- help functions inside software, AUTODESK

Reference 8: CD-Adapco. "STAR-CCM+ Manual", version 10.02.012 edition